



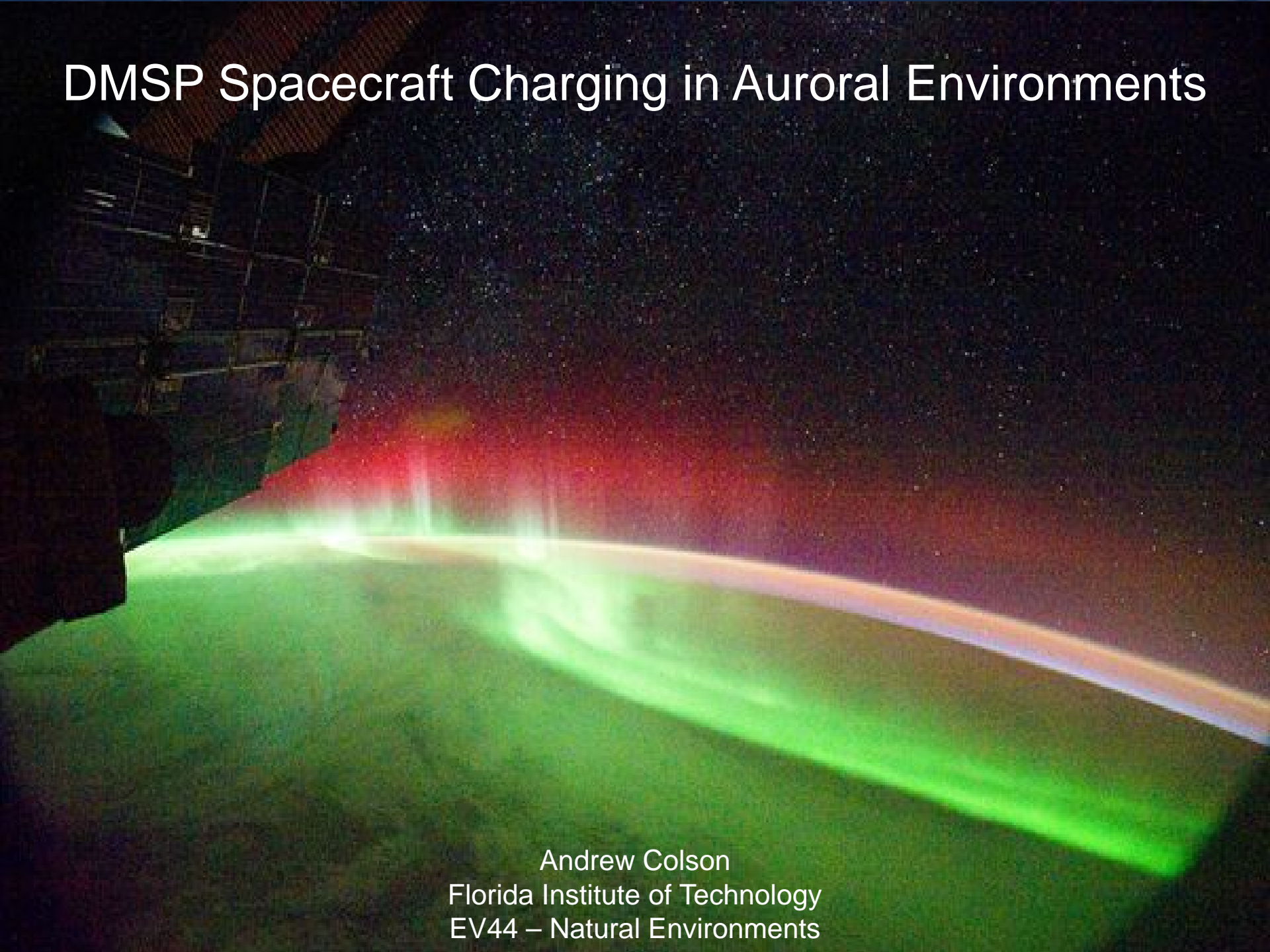
NASA Marshall Space Flight Center

Undergraduate Student Research Program (USRP)

Intern Presentations Fall 2011

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Bldg. 4200, Room P110

DMSP Spacecraft Charging in Auroral Environments



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EV44 – Natural Environments

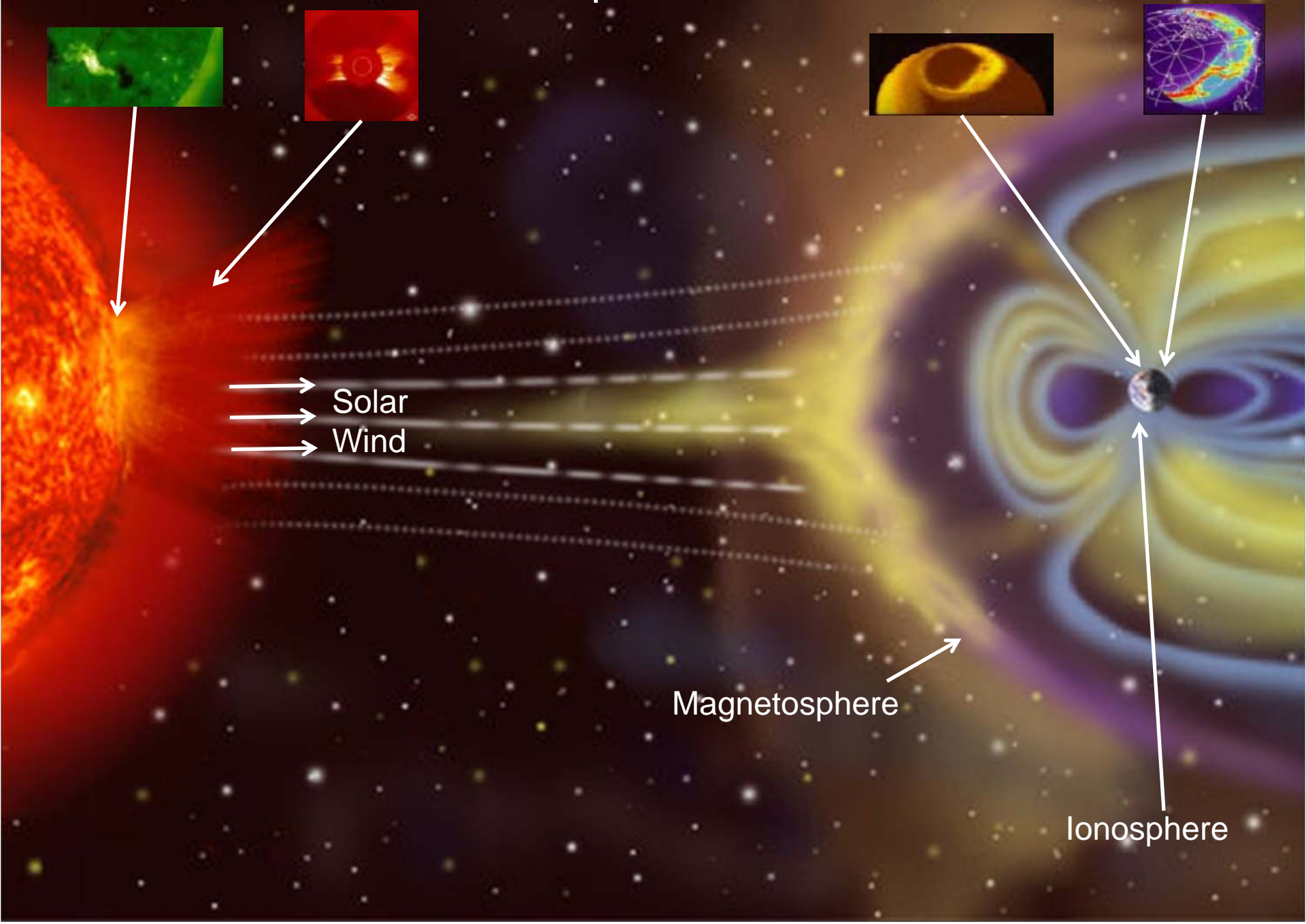


Overview



- I. Solar and Space Environment
- II. DMSP
- III. Spacecraft Charging Background
- IV. Effects of Charging and Space Environments
- V. Early Studies of DMSP Charging
- VI. Results and Conclusions

Solar and Space Environment



Defense Meteorological Satellite Program

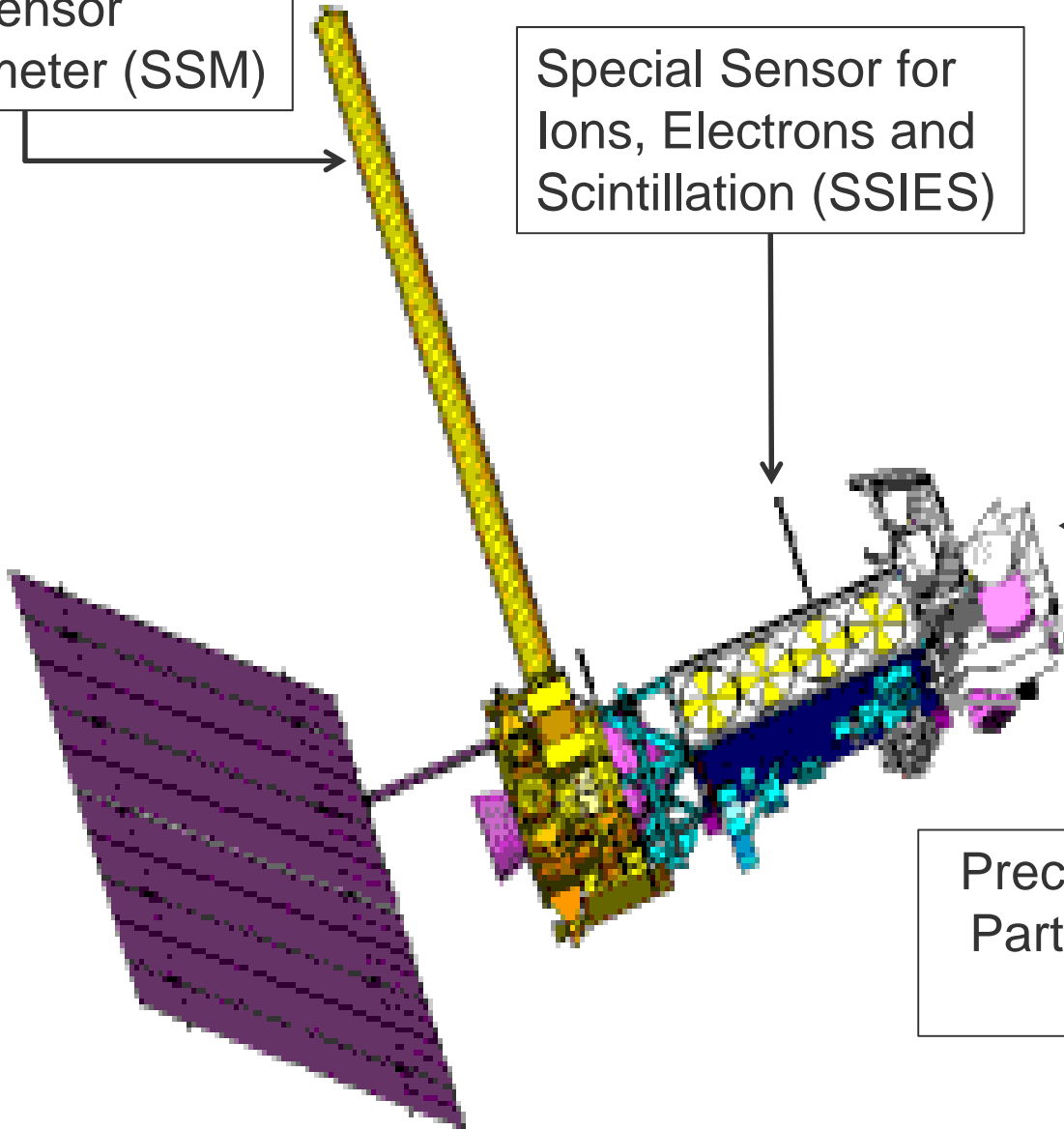


Defense Meteorological Satellite Program

Special Sensor
Magnetometer (SSM)

Special Sensor for
Ions, Electrons and
Scintillation (SSIES)

Precipitating Energetic
Particle Spectrometer
(SSJ/4-5)





Spacecraft Charging Background

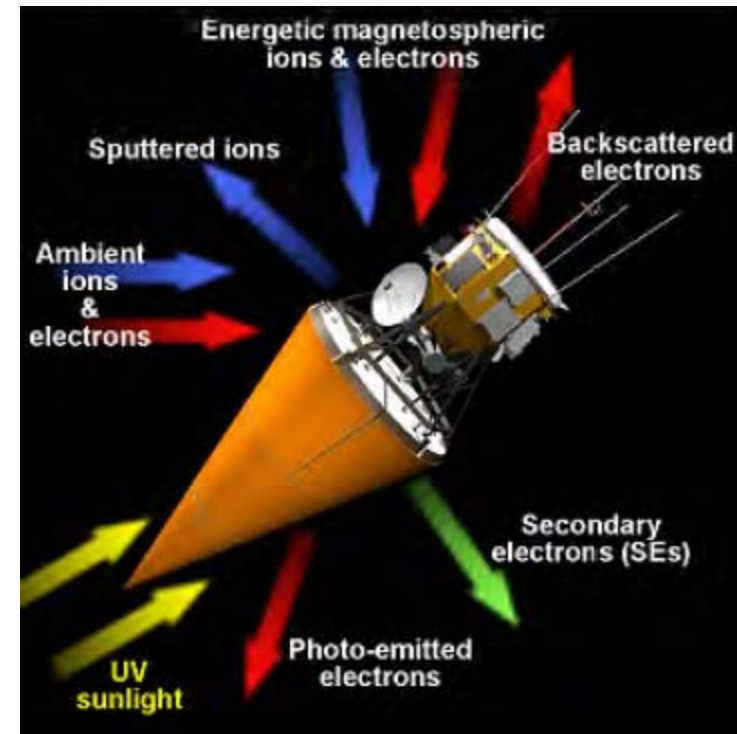


Spacecraft charging refers to the effects of physical process which produce...

- Electrical potential or voltage differences between the spacecraft conducting structure and the surrounding space plasma environment
- Voltage differences between electrically isolated parts of the spacecraft

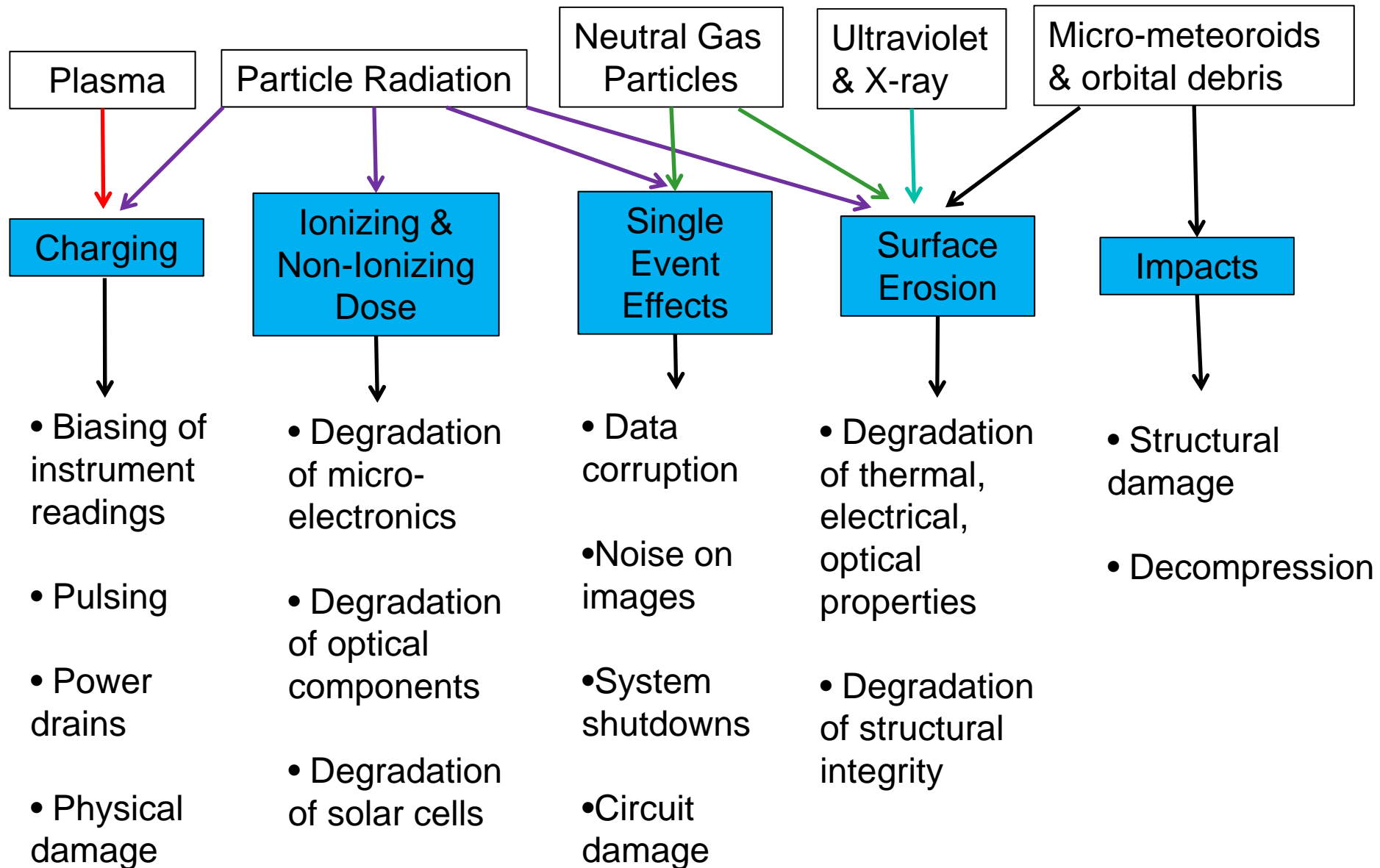
The accumulation of charge on spacecraft and its components is described and quantified using the current balance equation:

$$J_{elec} + J_{ion} + J_{pe} + J_{sec} + J_{back} + J_{art} = 0$$





Effects of Charging and Space Environments



JAXA ADEOS-II Failure



Loss due to bus voltage of 50 volts attributed to interaction between plasma environment and multi-layer insulation



Early Studies of DMSP Charging



Gussenhoven et al. (1985)

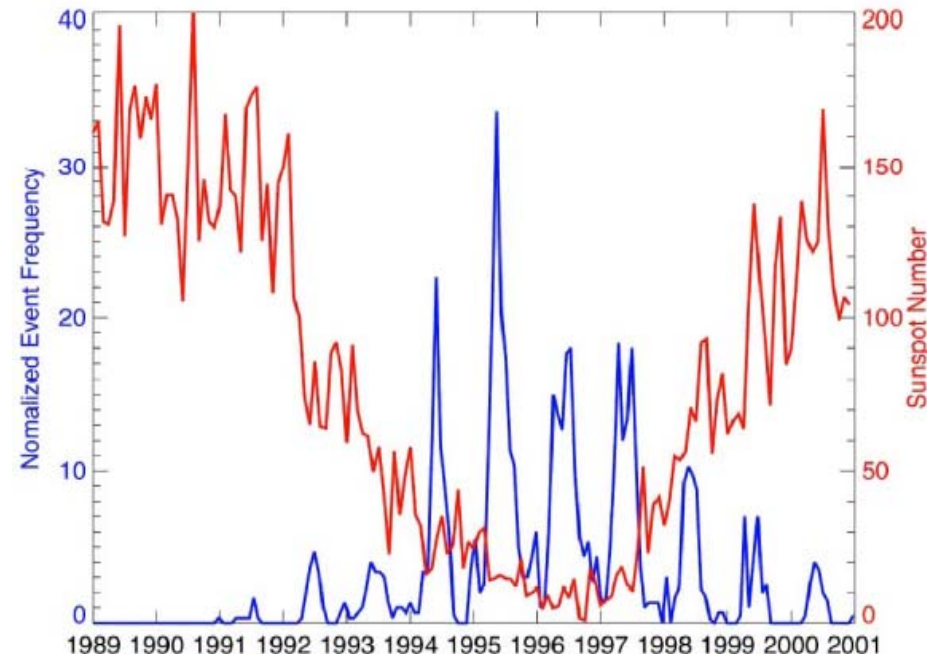
- Surveyed F6 and F7
- Documented 9 charging events over 100 Volts and a max voltage of 685

Frooninckx and Sojka (1992)

- Surveyed F6 – F9
- 184 charging events from 46 to 1430 V

Anderson and Koons (1996)

- First to observe anomaly associated with charging in the aurora
- Peak frame potential of ~460 V
- 704 charging events over 1.5 solar minimum period

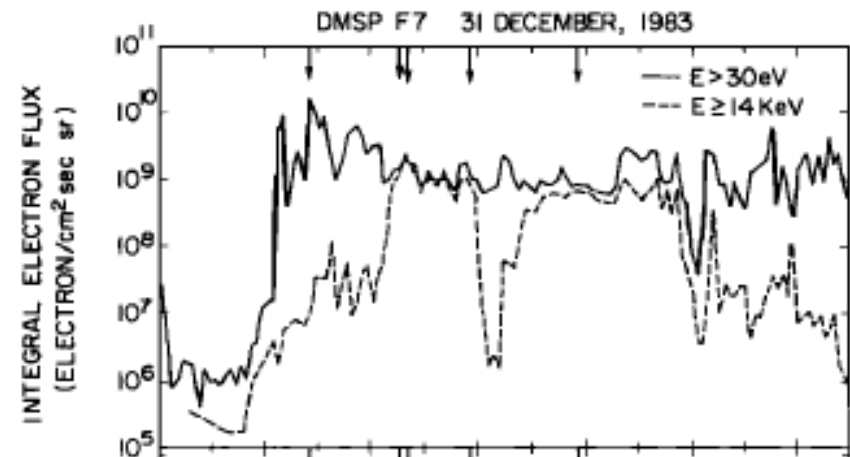
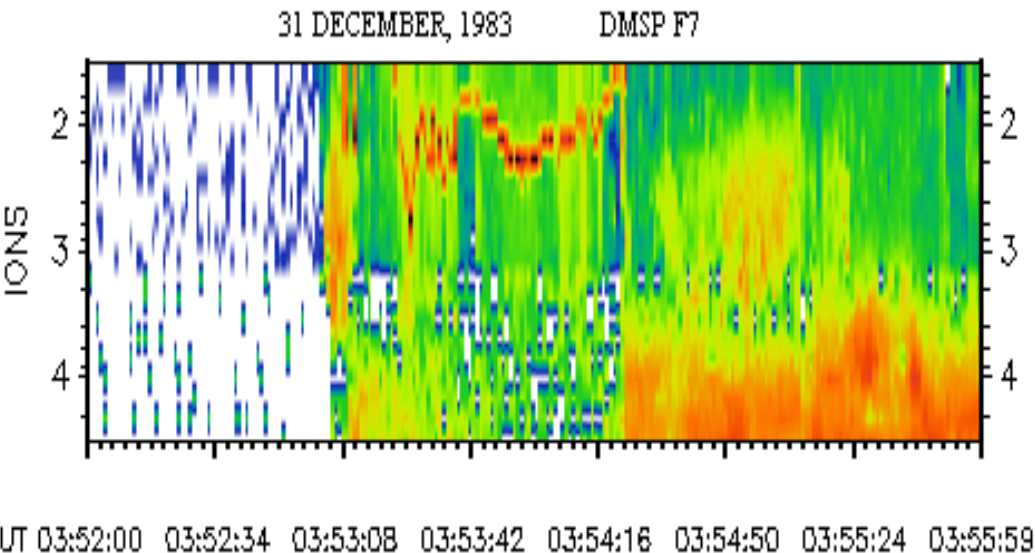


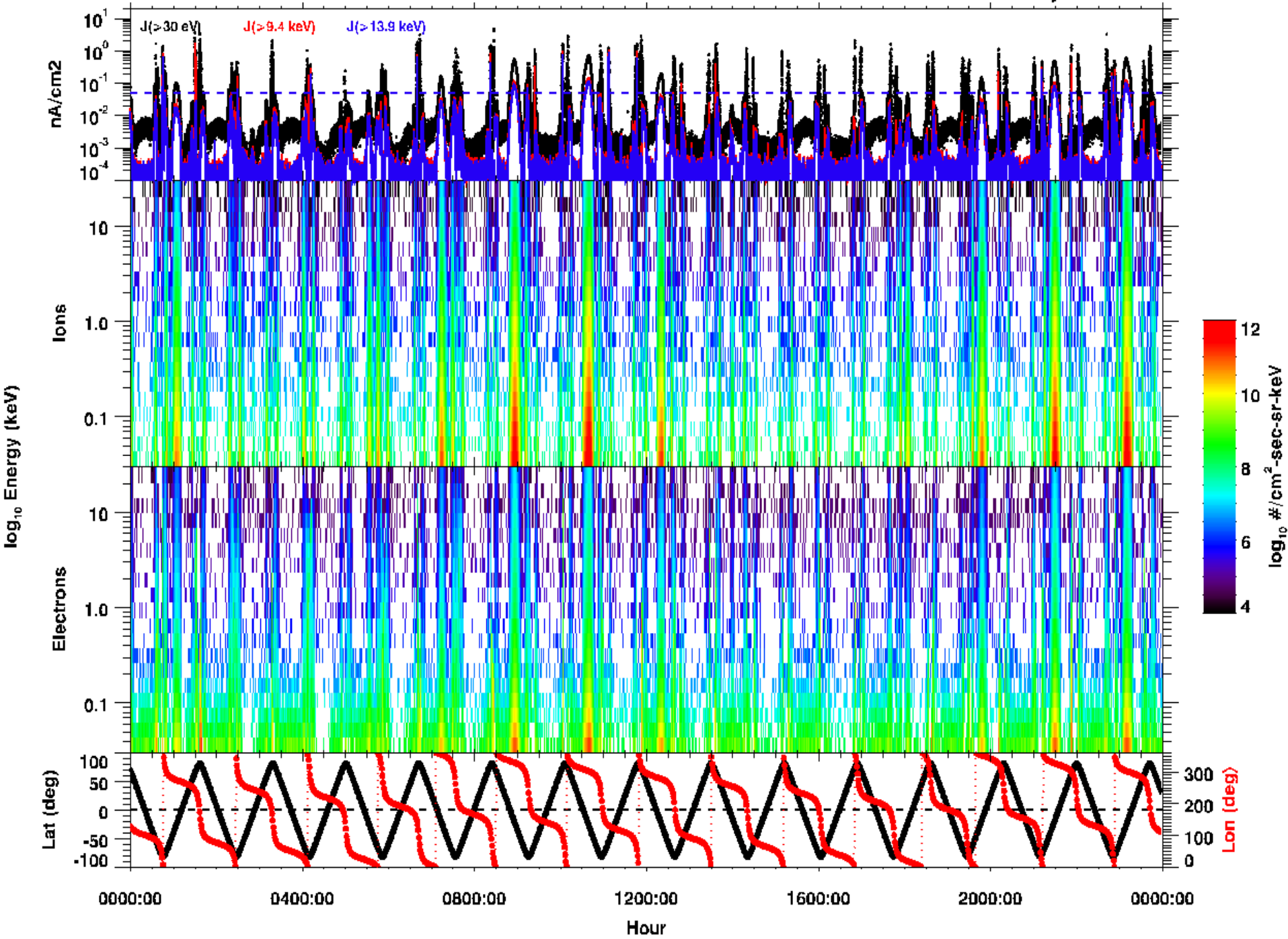


Criteria for Identifying Charging Events



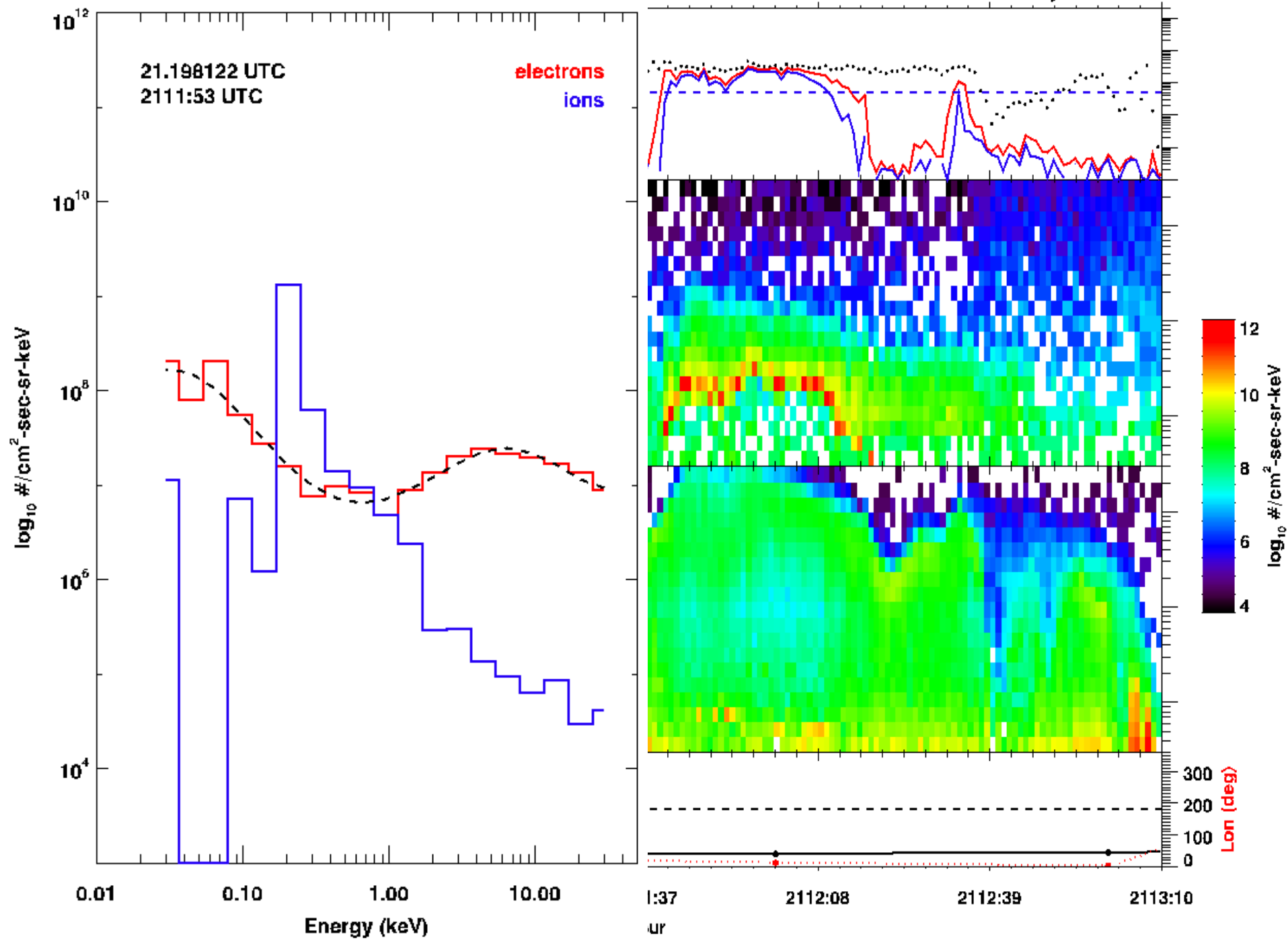
- I. The integral number flux of electrons over 14 keV must exceed $10^8 \text{ cm}^{-2} \text{ s}^{-1} \text{ sr}^{-1}$
- II. The current density must be greater than the Gussenhoven level of significance of $\sim 10^{-1} \text{ nA cm}^{-2}$

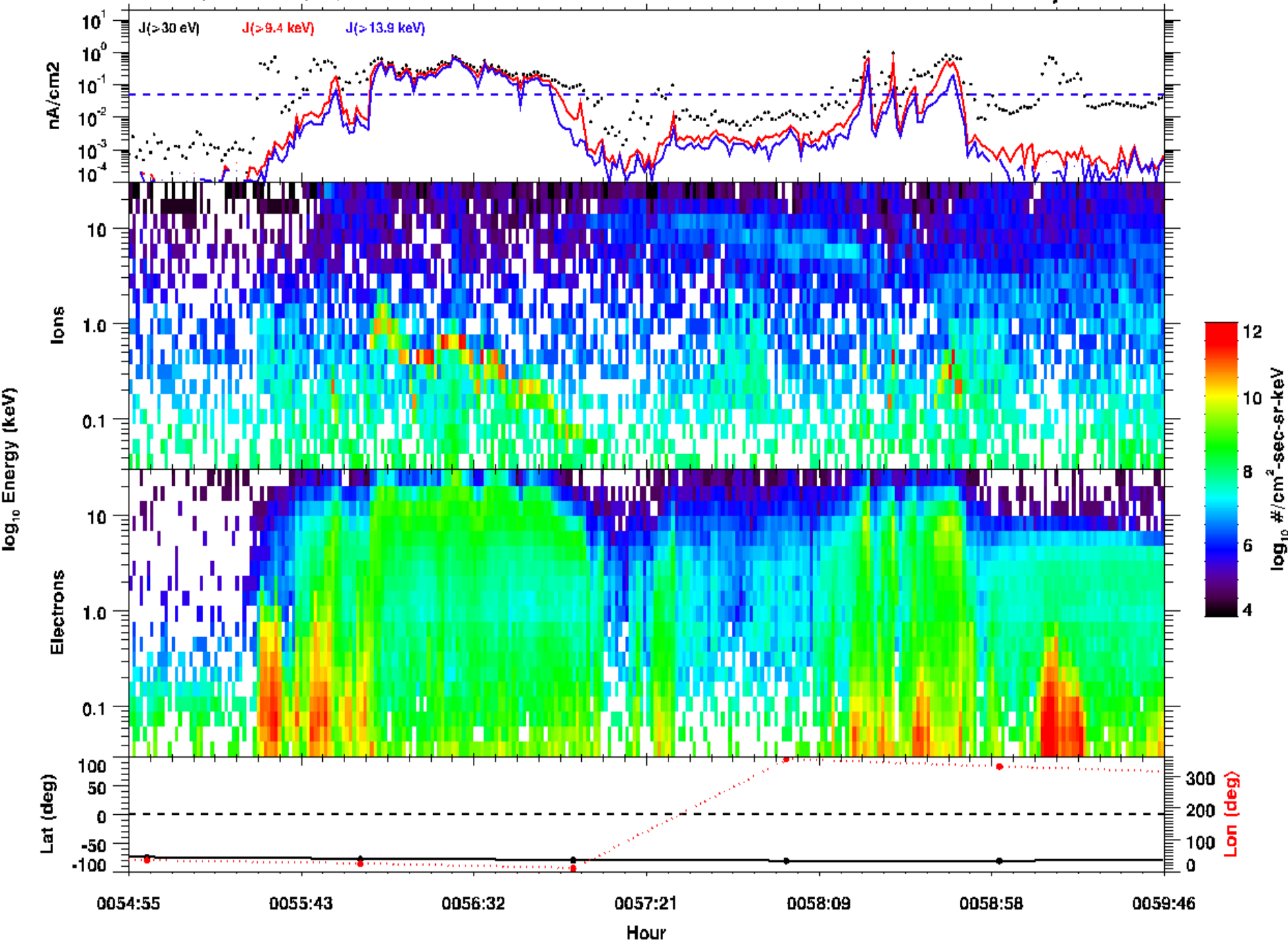




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Results and Conclusions



June 2011	F16	F17	F18
Number of Events	17	6	7
Longest Duration (seconds)	58	36	71
Average Duration (seconds)	20.9	14.8	16.9
Minimum Voltage (Volts)	46.7	66.9	68.7
Maximum Voltage (Volts)	1030.7	1435.9	700.1

- Results agree with those of early studies
- Recorded the highest voltage seen in a charging event
- Develop an algorithm to detect charging events
- Find a relationship with geomagnetic activity

